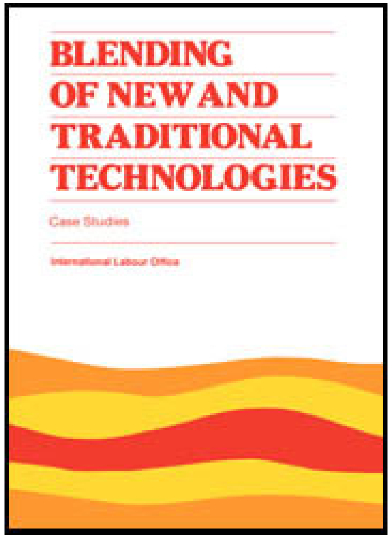

Blending of New and Traditional Technologies - Case Studies (ILO - WEP, 1984, 312 p.)
PART 3: CONCLUSIONS AND FUTURE ACTION
Chapter 20. Prospects for successful blending*

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PART 3: CONCLUSIONS AND FUTURE ACTION

Chapter 20. Prospects for successful blending*

*Contributed by the ILO.

THE CASE STUDIES in Part 2 can be grouped into the following categories in a descending order: (i) microelectronics; (ii) biotechnology; (iii) photovoltaic cells (solar technology); (iv) remote sensing; (v) communication satellites; and (vi) new materials. Although no exhaustive search and investigation was possible within the time available, we can conjecture that commercialisation and

application of the above emerging technologies follow roughly the above order especially in the case of developing countries. For example, there seems to be a consensus that the microelectronics applications are more widespread than those of biotechnology, new materials or photovoltaic cells. This seems to be confirmed by our limited sample of case studies. In our search for operational/experimental projects we were struck by a large amount of very general literature on the new technologies. The bulk of this literature deals with general trends, forecasts and possible applications in the future; some of it is in the nature of feasibility studies which may or may not materialise. There is very little documentation and analysis of projects and experiments which seem to be under way as is evidenced by selected examples given in the Annex. As expected, it was much easier to find examples of ongoing projects in the field of microelectronics than of other new technologies. Even so, it was difficult to locate many ongoing projects with a specific focus on blending of new technologies with traditional economic activities with a view to improving the standards of living of the rural and urban poor in developing countries. Even in the advanced countries, it was rare to find specific examples of applications of emerging technologies to small-scale businesses and traditional industries.

I. CONCLUSIONS OF THE CASE STUDIES

Most case studies included in Part 2 demonstrate the lack of any conscious effort on the part of governments of both developed and developing countries to gear the frontier technologies towards improving the lot of the world’s poor. Most examples and projects on blending of new technologies with traditional economic activities are *ad hoc* and financed mainly by international funding agencies without the necessary participation of the host countries. This is discussed in

Chapter 13 on palm oil cloning in Costa Rica which notes that very few research and development (R and D) personnel are Costa Ricans and the subsidiary of a multinational enterprise has no organic links with the local scientific and technological community.

In many cases, the financial participation of developing countries is impossible, but participation of their skilled manpower is both possible and essential to ensure that local technological capacity is built up over time through learning by doing. A corollary to this is the need for developing countries to train required skilled manpower in adequate supply and quality to assimilate new technologies more efficiently. Even in the advanced countries like the United Kingdom, the skill shortages in the use of microelectronics were felt by both small and large enterprises (see Chapter 7).

Second, the experience with assessments of projects shows that very little if any systematic data collection is done on a regular basis. This makes it extremely difficult, if not impossible, to evaluate the success or failure of the projects or experiments in the light of any systematic criteria or quantitative parameters. Thus, regular data collection needs to be built into the design and operation of projects.

As noted in Chapter 1, utilisation of many new technologies can occur in an integrated manner to obtain optimal results. Yet in practice it is rare to find such cases of interaction. Only Chapter 5 on the use of personal computers in Italian biogas plants presents a concrete example of blending of solar technology, biogas, and personal computers. This is an area for fruitful and innovative pioneer projects.

As expected, problems are associated with some blending experiments and projects. In Malaysia (Chapter 12) the cloning of palm oil trees upgrades an existing industry and appears to be highly beneficial. However, in Costa Rica, application of biotechnologically improved techniques to palm oil production (Chapter 13) will merely hasten the substitution of palm oil trees for more labour-intensive banana production with an attendant loss in employment. Similarly, while satellite technology for remote sensing is being applied beneficially in Third World countries (Chapter 15), India's satellite television broadcast for rural education (Chapter 16) has fallen far short of its original goals.

Most of the operational cases are experimental or pilot plants. With the exception of microelectronics, the use of most emerging technologies in developing countries is not yet widespread. This is due partly to the high cost of such technologies (e.g. the case of photovoltaic cells discussed in chapters 18 and 19) and partly to a slower rate of advance in some new technologies than in microelectronics. In addition, by the very nature of these technologies (some passed the laboratory stage only within the last five to ten years) many applications to traditional activities have not stood the test of time. In the case of remote-sensing techniques, for example, the first remote-sensing satellite was launched in 1972; since then scientists have been concerned mainly with establishing its potential.

On the positive side, the case studies in Part II show that blending of new and old technologies is feasible and can be successful. Electronic load-controlled small hydro-electric power generator (Chapter 10) is a case in point. The economic results of this technology are positive in three developing countries and its use is subject to local control. The case of using numerically controlled machines on

traditional lathes in Brazil (Chapter 9) can also be regarded as a success although progress has been attained slowly due to a number of obstacles. In the field of biotechnology the attractive potential for fruitful blending is illustrated by Chapters 11 and 14 which deal respectively with more efficient metal extraction through bacterial leaching and the upgrading of the production processes of African foods through fermentation technologies. The Italian Commission on Nuclear and Alternative Energy Sources has achieved improved efficiency in biogas plants through the use of personal computers (Chapter 5), and believes some of the results can be transferred to developing countries. Microcomputer application to Portugal's agricultural sector (Chapter 3) gives an example of blending in a country generally considered as a transitional economy just beginning to emerge as developed, while still exhibiting some characteristics of the Third World.

Although some blending experience has shown little local control or absorption of newly introduced technology, for example, technological innovation in Costa Rican palm oil production (Chapter 13), this is not always the case. The blending of numerically controlled machines with traditional lathes in Brazil (Chapter 9) shows how domestic manufacturing firms can learn through experience and experimentation. Due to a particular combination of circumstances described in Chapter 11, the development of biotechnology for metals extraction in the Andean Pact countries is also very largely an indigenous effort.

The Prato textile experience (Chapter 8) suggests that under some circumstances, the technological upgrading of decentralised traditional industries is quite feasible. However, it also cautions the policy-makers in developing countries on the difficulties of accomplishing this goal. Prato has a long historical tradition of

operating in a disaggregated way and has been able to adjust by establishing an informal communications system, financial institutions and transportation infrastructure. In this sense, Prato offers to developing countries an ideal picture of a decentralised traditional industry that exhibits great ability to integrate and absorb new innovations.

Finally, a valuable policy clue may be derived from the fact that new materials, while well into the applied stages in developed economies, are not finding applications in the developing countries to any great extent. Yet, Chapter 17 leads one to believe that beneficial applications of blending can be found. While a constant scanning of possible applications should be performed for all emerging technologies, such action is especially urgent for the new products of materials science.

II. PREREQUISITES FOR SUCCESSFUL BLENDING

A number of requirements will need to be met before proper and successful blending of emerging and traditional technologies can be achieved. These requirements will vary from sector to sector and from one type of producer to the other (e.g. small farmers, producers in the urban informal sector, and large-scale producers).[1]

First, in-depth knowledge of the nature and characteristics of traditional activities/technologies with which new technologies are to be integrated, is most essential. For a proper fusion into the traditional economic and socio-cultural environment and practices, the use of new technologies should "improve the efficiency of these practices without radically altering the associated skill and

input requirements."[2] For example, in the case of traditional farmers, a new technology should not demand large cash outlays to which a small farmer has no access. Neither should it involve a high degree of risk.

Second, the local participation and involvement of the potential beneficiaries is essential for the success of the blending process and the pilot projects that might be launched to implement it. The problem of the lack of R and D linkages with the productive sector is now well-known. The need for such linkages seems to be even more crucial in a strategy of blending new and old technologies. This is due partly to the relative lack of knowledge and understanding on the part of both R and D personnel and the producers of emerging technologies.

Thus, a third requirement is the need for the dissemination of information on: (i) new technologies and their potential benefits to the users; and (ii) prevailing practices and the pattern of local resource use, organisation, and waste collection etc. in a given sector for use by the R and D and extension personnel. Knowledge of traditional techniques as well as the cultural, social and political forces which influence prevailing production patterns is also essential. For example, Chapter 14 shows that a better grasp of the contemporary fermented foods of Africa and an upgrading of these technologies through conventional biotechnology is a necessary precondition for the application of microelectronics and more advanced biotechnology. Also one might recall that the disappointing results of India's village education through satellite TV broadcasting (Chapter 16) were not due to the technology *per se.* Rather, the poor results were due to the failure to judge accurately the public demand for entertainment programming, the greater political clout of urban India, the enormous diversity of village economies within the Indian regions and sub-regions, and similar other non-technological conditions.

Fourth, many of the new technologies are likely to demand new and additional types of software and infrastructure without which their utilisation is doomed to failure. Although miniaturisation of many of these new technologies - particularly microelectronics - enables their use in decentralised production, provision of *centralised* infrastructure and services, mostly by the public authorities, would be needed. Herein lies an important role for the governments of developing countries in the promotion of a blending strategy.

Readily available and identifiable markets for processes and products is another precondition for the successful integration of new technological innovations with traditional productive activity. Pilot experiments need not wait until the market potential has been exploited. There are time lags between trials and demonstrations of the new innovations and their widespread use on a commercial basis.

Finally, the selection of new innovations to be integrated with traditional activity should be based on a systematic set of criteria - economic, social, cultural and environmental - and a comprehensive framework of assessment of potential benefits to the target groups. In the final analysis, the nature of the desired benefits will determine the approach, type and scope of applications of the new technology (see the following section). We believe that the improvement of standards of living of the rural and the urban poor in developing countries should be one of the major objectives of the blending strategy.

III. NEED FOR ACTION

Concerted action is needed at different levels - international, regional and sub-

regional, national and local - if the strategy of blending is to work in practice. As some action has already been initiated at the international level, we begin with it below.

International Level

To recapitulate past action, the United Nations Advisory Committee on the Application of Science and Technology for Development (ACSTD) has been most active in giving flesh and blood to the concept and strategy of integrating emerging and traditional technologies. An ad hoc panel on the subject was held in Los Baos (Philippines) in December 1982. This panel recommended, inter alia, the launching of "pioneer projects" to illustrate and demonstrate the practicability of the concept of blending. To take the idea of "pioneer projects" a step further, it recommended the preparation of this volume. A workshop as a follow-up to the ad hoc panel took place in Tokyo (Japan) in April 1984. The purpose of this workshop was to: (i) evaluate completed and ongoing projects related to emerging and traditional technologies; (ii) bring to the attention of governments and funding agencies, including the United Nations system, new innovative "pioneer projects" in both developing and developed countries; and (iii) discuss the modalities of launching a selected number of these projects at the national and sub-regional levels with the support of existing national, regional and international institutions like the International Rice Research Institute, Regional Centres for Technology Transfer, and national research laboratories. Part 2 of this volume on "Case Studies" provided useful background information for the deliberations of the workshop.

In addition to the above types of workshops, exhibitions and technology fairs

specially focused on examples of blending may be another means of demonstration and diffusion of new innovations.

Technological change is a continuous process. As new innovations take place and existing ones extend their frontiers, new information and insights are likely to be available. International governmental organisations like the United Nations agencies and organisations, and non-governmental ones like the International Council of Scientific Unions (ICSU) are ideally suited to disseminate information on a systematic and regular basis. A modest beginning has already been made in this direction but the challenge is too great for any single agency to handle the task in isolation. Therefore, it is desirable that a number of international agencies and organisations undertake this task in unison. As a first step, a common assessment framework needs to be agreed upon. In the light of this framework, "pioneer projects" and other experiments underway need to be assessed and evaluated. Here the international donors which finance many of these experiments also have a role to play. Proper assessments and evaluations are very stringent in data requirements. Therefore, it is desirable that funding agencies insist on components of data collection and periodic evaluation being built into the design of projects that they process.

Additional and more systematic information should enable more rigorous assessments and evaluations than those contained in Part 2 of the volume. For example, additional information on case studies included in Part 2 could enable existing assessments to be done in greater depth especially to examine the degree and limitations of integration possibilities in the existing projects. More data particularly on items contained in the Annex could also make possible additional assessments covering these examples. It was not possible to do any meaningful

case studies of these examples for lack of data. It would be particularly useful to undertake a few assessments of failures and their causes. These could provide suitable guidelines for avoiding pitfalls in future pioneer projects. In the light of the above, it is recommended that the volume should be updated periodically, with a publication of supplements. The supplements could also report on the development of a suitable methodology on which some work has already been initiated.[3]

Additional information can also be disseminated through journals and newsletters many of which are already in existence. However, none of them pays any special attention to the blending of new technologies with traditional economic activity. To quote a few examples of existing newsletters, UNIDO has a *Microelectronics Monitor* and a *Genetic Engineering and Biotechnology Monitor,* the ILO issues a special section on "new technologies" in its *Social and Labour Bulletin*, UNU issues abstracts of selected solar energy technology, ASSET, and UNESCO encourages biotechnology networks such as the *"Mircen".* In addition to the newsletters and networks, UNCSTD proposes to publish a semi-annual journal - *ATAS Bulletin.* It would be useful if the existing channels were tapped to collect more systematic information on cases of blending. ACSTD may wish to recommend that the above organisations and agencies of the United Nations system pay special attention to data collection on cases of blending.

Regional and Sub-regional Level

The cost of development of most new technologies is too exorbitant for individual developing countries. For example, in 1979, semi-conductor firms in the United States invested US$447 million in R and D - an amount equivalent to 5.7 per cent

of their sales.[4] Similarly, private research on biotechnology in Japan amounted to US$203.5 million, and the equity capital of private biotechnology enterprises in the United States is in the neighbourhood of US$1,000 million.[5]

Furthermore, there is what is generally known as the "assurance problem" in undertaking R and D of the type involved in the generation of new technologies. This means that the high cost and substantial risks involved discourage individual countries from undertaking research without an assurance that others will do likewise.[6] The experience of R and D in microbial leaching in the Andean Pact countries (Chapter 11) seems to bear this out. Research on microbial leaching was carried out jointly by the Andean countries to ensure economies of scale and reduce risks. However, regional cooperation in research of this kind presupposes an interest on the part of the participating countries, a potential market and existing or planned research facilities and qualified manpower. Groupings like the Andean Pact, the ASEAN, and more recently the new Association of South Asian Nations, provide an institutional framework within which joint R and D projects need to be explored. In addition to the possibility for pooling scarce resources, regional R and D organisations would be in a better position and have a greater will to investigate applications of new technologies to location-specific traditional activities.

A more fruitful area for regional cooperation may be the development of software in which the developing countries could wield a comparative advantage. Scope also exists for regional training facilities for the *adaptation* and *utilisation* of new technologies more than their *development* within developing countries.

National Level

Action at the national level can take several forms and is required on several fronts, namely, research and development strategies and policies, training, diffusion of innovations, their commercialisation and direct and indirect incentives for the optimal utilisation of known innovations.

1. "Pioneer" Projects

To give a practical orientation to the task, ACSTD has recommended the launching of "pioneer projects". However, in spite of some discussion on the subject there is no clear consensus about the definition, nature and criteria of selection of these projects. For example, are "pioneer" projects identical to pilot and experimental projects? Are there any special features which distinguish them from pilot projects? The Los Baos panel assumed that pioneer projects were identical to pilot projects. While an element of uncertainty and the unknown is bound to be present in either, it is more likely to be greater when a pioneering uncharted territory is being trodden.

A. Selection criteria. We believe that a "pioneer" project in a blending strategy should satisfy the following criteria:

(a) It is relevant to the felt needs of the population;

(b) It has a positive (potential) impact on a large number of people especially among the poorer groups of the population;

(c) It makes a contribution to concrete problem-solving;

(d) It has potential for widespread distribution;

(e) It can be implemented without too much additional cost, institutional support or structural change. If a pioneer project continued to involve large sums of R and D and other costs, it is unlikely to have immediate or short-run benefits for the target groups;

(f) It should be concrete in the sense that it consists of:

(i) a well-defined number of activities;

(ii) a well-defined output within a specified timeframe;

(iii) a built-in framework of evaluation to be done on the basis of benchmark data and regular data collection;

(iv) well-defined objectives in the light of which evaluations or assessments can be made;

(v) specific target groups or potential beneficiaries of the project (e.g. small-scale urban poor, unemployed youth, or women).

B. A Socio-economic Assessment Framework. Although some efforts have been made at conceptualisation of a blending strategy, no systematic evaluation/assessment framework to assess/evaluate projects and experiments at present exists. With the exception of case studies on photovoltaic cells (see Chapters 18 and 19) it was not possible to make any systematic cost comparisons among alternative technologies. Neither was it possible to determine such socio-

economic impacts as employment, training requirements and environmental effects. It was also difficult to separate the production processes and products in which blending had a major scope and those where it did not.

Nevertheless, for any blending strategy to be successful in future at both macro and micro levels, it is essential that a systematic framework of evaluation is designed. The following may be considered as some of the elements for such an evaluation:

(a) Minimum levels and types of skills required; length and duration of training and retraining;

(b) Alternative materials and other inputs needed to produce and apply new technologies locally;

(c) Market potential for the products and processes for which new technologies are used;

(d) Cost-reducing factors, e.g. organisational and administrative efficiency;

(e) Employment-generating effects;

(f) Social and environmental effects, e.g. health hazards and effects on social modes of behaviour;

(g) Spill-over effects for other economic activities or social aspects of life (social services, health care delivery, etc).[7]

The above elements can be presented in the form of a summary table/matrix such as Table 20.1:

Table 20.1 Technology Assessments/Evaluations

Variables	***Economic***	***Social***	***Other***
Technology			
	Scale, product, skills, capital, energy, materials, etc.	Employment and health and occupational safety, behaviour modes	Consumer acceptability, complexity of administrative requirements, etc.
Microelectronics Biotechnology Communication satellites New materials Solar technology	x	0	

Notes:

x indicates positive effect in terms of lower costs and energy saving, for example;
0 indicates negative effects in terms of displacement of labour, or occupational hazards.

The purpose of such a summary table is to provide easy reference for busy policymakers and executives who may, nevertheless, be able to evaluate at a glance a potentially adaptable new technology and refer it to competent colleagues for further study and perhaps possible adoption and implementation.

The above table does not give an exhaustive list of variables that should be taken into account in any evaluation. Instead, it gives an illustrative check-list of *minimum* variables in any comparative assessment or evaluation of concrete experiments and projects.

We assume that the technology and its application is technically proven. This is not always the case, as is shown by the example of photovoltaic cells in irrigation. Due to the low power, the pumps could not pump as much water per unit of time as diesel tubewell pumps. Therefore, technical factors, including the technical performance and meteorological and hydrological factors (a certain blending might work well in one area but not in others) should constitute an important part of any assessment.

Concerning the economic factors, let us take the case of scale of production, for example. An innovation will be more widely diffused in developing countries and thus will have a more positive effect if it requires large scale of output in order for it to be profitable. The impact of new products associated with new technologies depends on the extent to which they allow quality improvements to be purchased at lower prices and on whether they extend the range of choice or displace some or all existing products. These effects of new products are likely to depend largely on consumer tastes and acceptability, both of which, in turn, may often be highly culture-specific.

The input requirements of the new technologies (the economic variables) determine whether they save on these scarce resources (and hence lower costs) or whether they require more of these resources to produce each unit of output.

The employment impact (one of the social variables) will be positive or negative depending on whether the number of jobs that are directly and indirectly created, exceeds or falls short of the number of workers that are displaced by the innovation.

On occasion, new technologies may have a uniform (positive or negative) impact on the variables listed in the table. However, in most cases positive effects with respect to some of the variables will be offset by negative effects of others. The *net* impact of the technology on society will then depend on the weight or importance attached by society to the different variables. For instance, in an example in the table, a reduction in costs (and economy in energy use) is accompanied by a negative employment effect. Therefore, the overall impact depends on the weight society attaches to each which, in turn, depends on its goal.[8]

C. Scope and Limitations of Blending. In the choice of pioneer projects it should be kept in mind that not all cases of blending of new and traditional technologies would inevitably be feasible. Thus photovoltaic-powered irrigation might be feasible in a situation where soil hydrology allows shallow wells used by these systems to remain full throughout the year; in other areas with different soil conditions the same system would be unsuitable. Therefore, it is recommended that initial feasibility and scope of blending in concrete situations should be

investigated before making a final selection of pioneer projects. Radnor *et al.*[9] add another dimension to the selection and assessment of pioneer projects, that is, the degree of integration of new and traditional technology. According to them, some applications may have a major traditional component, yet they may not be feasible for reasons of cost and complexity, etc. For example, we noted above that photovoltaic cells are not yet feasible for high power applications due to high cost. Other applications may be quite feasible on grounds of cost and technical efficiency but may involve little integration with traditional activities. Therefore, an *optimal* mix of feasibility and degree of integration is desirable. Examples of feasible and integrative new technologies are:

- off-line microcomputer uses for agricultural management (crop production and livestock management, irrigation and pest-control) and for planning and decision-making;

- on-line uses of microprocessors to control irrigation, fermentation, moisture level in crop storage bins, village power supply systems and processes in traditional industries;

- photovoltaic electricity generation for low-power applications such as supplies to refrigerators in rural clinics and communal radio/TV sets;

- use of microorganisms for the extraction of minerals from ores and for waste treatment;

- use of DNA, cell fusion, bioreactor and other biotechnological and chemical techniques to breed new varieties of crops, improve agricultural

productivity, provide cure for tropical diseases and offer alternative sources of energy for rural areas;

- use of natural-fibre reinforced composites in rural construction, and in the manufacture of village technologies such as wood-burning stoves, windmills and hydro-turbines;

- remote sensing used in conjunction with conventional methods of crop forecasting, hydrological surveys, prospecting for minerals, etc.

2. Reorientation of R and D

In most developing countries, R and D is concentrated on a small segment of modern industry, to the almost total neglect of the needs of the bulk of the population. The latter are engaged in small-scale businesses and economic activities and therefore lack effective demand and purchasing power to benefit from the results of R and D. Without the direct intervention of government to change the R and D priorities in favour of the smaller sectors of society, it is most unlikely that the rural and the urban poor will ever benefit from science and technology. The new technologies have an advantage in so far as they are easily miniaturised (particularly microelectronics) and utilised on a decentralised basis. For example, minicomputers costing as little as several hundred dollars, no larger than books and weighing 2 kilograms or less are now available.[10] Once a new strain of an organism, or new enzyme, is produced and marketed it should be reasonably scale-neutral in its use. Similarly, small or medium-sized manufacturing firms can make use of new materials without necessarily altering the size of their operations.

It follows that the prevailing R and D strategy in developing countries needs to be reoriented in favour of small-scale operations if the strategy of blending new technologies is to succeed. This may require greater proportion of the limited R and D expenditures to be devoted to the needs of the rural and urban informal sectors; it may also involve the launching of a selected number of pilot projects to demonstrate the effectiveness of blending of new with traditional technologies.

3. Organisation of Production

Greater emphasis of R and D on smaller sectors alone would not be sufficient. It is also essential to change the product- and industry-mix in favour of small-scale operations. This can be done through active encouragement by the government in the form of: (i) protection; (ii) ensuring access to credit, foreign exchange, and other inputs; and (iii) removal of various discriminations against small firms.

The experience of the Prato textile industry (Chapter 8) underlines the importance of public authorities providing a package of services. It is unlikely that the new and emerging technologies can be successfully integrated without government support and infrastructural facilities like the teletext experiment proposed for Prato.

Whenever indivisibilities occur and production on a large scale is essential, the costs of technology utilisation could be shared through cooperative modes of production and through sub-contracting arrangements.[11]

4. Education and Training

Emphasis has to be placed on education and training in order to create an awareness of and a motivation for successful blending of new technologies with traditional activities. Given the very nature of new technologies, tasks would continually change; the expertise has therefore to be equipped to respond to these rapid changes. As a long-term strategy, students in educational institutions should be trained in new technology developments particularly as they relate to their specific disciplines. Thus, students of agriculture should be introduced, even at an early stage, to computer techniques and their possible applications to agricultural management; geology students should benefit from an understanding of remote-sensing techniques in addition to conventional methods of geological investigations; the principles of DNA and other recent advances in biotechnology should be included in the biology syllabus in universities and colleges. Given the short time required for curricula development, concrete efforts should be made in this direction.

In the short term, training/retraining of personnel undertaking traditional activities is required if blending is not to result in massive unemployment. Training would no doubt be easier in some cases than in others. Thus, in off-line computer applications, personnel could be trained in two weeks in basic data entry and analysis while other applications such as interpretation of satellite images would require much longer training. Also, while some new technologies lend themselves to training-by-doing, others require a considerable understanding of the basic concepts.

Specialised training at a high level would no doubt be required. This type of training should aim, first, at creating self-reliance in mastering the new techniques and their applications and, second, in the specification of systems suited to

specific needs. Structures exist for specialised training in many of these techniques but more fellowships are required for developing countries to be able to benefit from these facilities.

Education of decision-makers involved in traditional activities is required in order to inject the necessary enthusiasm for adopting new technologies with potential advantages. In some cases, there is a basic lack of awareness of the existence of these new technologies and of their capabilities for blending with traditional ones. Thus, the availability or potential of photovoltaic cells to supply essential services in many rural areas, is unknown to many decision-makers. Even in cases where the knowledge exists, scepticism about the new technologies has hindered their use. It is for this reason that information on successful blending and demonstration projects would go a long way in educating these decision-makers.

IV. CONCLUSION

Does blending occur only under highly anomalous conditions or rather commonly? Is it, or can it be, a general multi-sectoral phenomenon, or is it more likely to be confined to a specific enclave of a single segment of the economy? Can blending be common enough and sufficiently beneficial to warrant actions to encourage and support it? The case studies in Part II and this concluding chapter give sufficient evidence to answer these questions in the affirmative.

To conclude, blending of emerging and traditional technologies is a reality although in the short run their scope and feasibility of application may be limited. However, in the longer run their feasibility can be enhanced through cost reductions and simplification, etc. The extent to which integration with traditional

activities and knowledge is possible will depend largely on an adequate provision for reorientation of R and D, education and training, and production structures. It will also depend heavily on the provision of an appropriate social and technical infrastructure.

NOTES AND REFERENCES

1. On this issue, see A.S. Bhalla and J. James: "New technology revolution: Myth or reality for developing countries?" in *Greek Economic Review* (Athens), (forthcoming).

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3. Bhalla and James, *op.cit.*

4. Juan Rada: *The impact of microelectronics and information technology: Case studies in Latin America* (UNESCO, Paris, 1982).

5. *Genetic Engineering and Biotechnology Monitor* (UNIDO, Vienna, No. 2, June 1982).

6. Bhalla and James, *op. cit.*

7. Some of these points are based on personal communication with Ms. M. Sicat (Philippines), an ACSTD member.

8. These points are based on an unpublished note by A.S. Bhalla and J. James, ILO, Geneva, 1983.

9. Wad, Radnor and Collins, *op. cit.*

10. Ford S. Worthy: "Here come the go-anywhere computers", in *Fortune* (New York). 17 Oct. 1983, pp. 97-98 and 100.

11. See A.S. Bhalla and J. James: "An approach towards integration of emerging and traditional technologies", in von Weizscker et al. *New frontiers in technology application, op. cit.*

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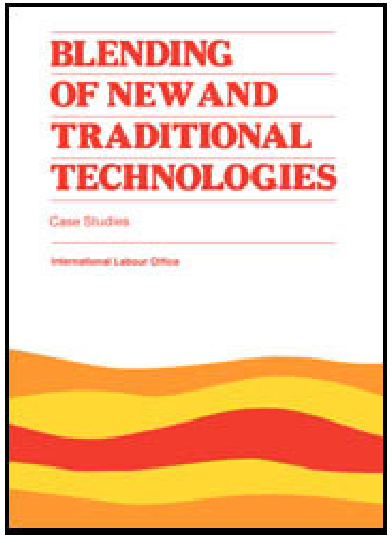

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ANNEX: SELECTED EXAMPLES OF EXPERIMENTS AND PROJECTS*

*** The Annex mainly contains examples of concrete applications of new technologies in traditional activities. A number of items (especially in the field of biotechnology) which are still in the development or pilot stages but show great potential have, however, been included. These are shown in asterisks.**

I. Microelectronics/Electronics

A. Microprocessor/Computer Applications

1. Computer applications in textiles (China). In May 1980, the Beijing Institute of Textile Science and the Beijing No. 1 textile plant installed a computer system designed to monitor 288 looms. The system collects operational data every ten seconds, processes it and prints out the output. It briefs the weaver on his/her own accumulated output and at the end of the shift provides him/her with various data concerning the weaver, production group, workshop and a breakdown diagnosis for each loom.

Prior to computer applications, manual methods resulted in an unnecessary high stock piling, and a high wastage rate of one per cent or a loss of one million metres of cloth in the Shanghai No. 1 Printing and Dyeing Mill. In June 1981, this plant established two microcomputer systems with the collaboration of the Huadong Institute of Textile Engineering, in order to improve quality control and forecast export markets. It is recorded that the new technology applications have reduced the wastage rate from one per cent to 0.1 per cent, or savings of 900,000 metres of cloth per annum.

2. Microprocessors in rice mills (Thailand). A rice miller in Thailand has bought a new rice-sorting machine with 11 microprocessors. This machine sorts out the grains that are diseased or stained, and thus upgrades the quality of the rice.

3. Computerisation in small/medium industries (India). A small firm in India is engaged in mass production of high precision engineering items. The company did not consider a fully-integrated computer system as economical in Indian conditions. Instead, a computer was introduced for handling bulk data of the pivotal materials control system, with manual follow-up based on computer summaries in the field of direct and indirect material consumption control, work-

in-process, inter-plant accounting, purchase planning, etc.

4. Use of computers in traditional medicine prescriptions (China). Microcomputers are being used in China for writing out prescriptions of Chinese medicines. In addition, the computers can calculate the prices and weight of medicines, keep accounts and also record the stock.[1]

5. Use of microcomputers in villages (Egypt). The project, financed by the UN Financing System for Science and Technology for Development (UNFSSTD), involves the use of microcomputers at the village level to generate a data base for a modern health information system. Egypt has been concerned about slow, fragmented and often contradictory reporting on the performance of health services. Under this project, the methodology of data collection has been prepared and training methods for managers and operators have been worked out. Seven microcomputer systems have been installed. With the help of Cairo University, the hardware/software system has been converted to Arabic language. The first phase of the project is operational in a district of Cairo with a population of one million and in the Governorate of Fayoum which covers six districts and another two million people.

6. On-line microprocessor control in traditional industries (United Kingdom)[2]. The British Sugar Corporation employs microprocessor controllers with their sugar evaporators and crystallisers. These controllers optimise several functions simultaneously and raise productivity and profitability by 75 per cent and 300 per cent respectively.

In the Midlands, a ferrous foundry uses microprocessors to control 12 moulding

machines. The microprocessors are also used on its sand mill. This has resulted in lower labour use, and improved quality/productivity.

A textile firm developed a microprocessor "black box" control system for sewing and finishing garments.

7. The Videotext computer-aided education system (Kuwait)[3]. Videotext is a two-way interactive communication system using specialised terminals, plus home television sets linked to host computers. The system in Kuwait would enable education at home through the use of television terminal hardware and specialised computer programming software to provide screen "pages" in Arabic and Latin characters. The system consists of a central computer linked via the telephone system to special television sets, and connected via a "gateway" system to data banks outside Kuwait.

8. Microprocessors in dairy farming (India). Microprocessors have been developed for measuring and recording the fat content of milk. This device was produced as a result of research and development in a major cooperative society in Western India. This decentralised cooperative collects milk from members twice daily and so copes with small quantities of milk. The price paid is based on the fat content of milk and traditionally a few drops of the milk have to be sampled to determine its fat content. The microprocessor method is non-destructuve and so milk is not wasted (in the traditional method the milk is destroyed in the process of testing). In addition records are kept of the fat content of each sample, thus allowing the cooperative to monitor the aggregate fat content, total amounts paid and the variation of the quality of milk over time. This replaced the cumbersome

conventional method used to record the large quantity of data.[4]

9. Computers in dairy farming (United States). In Wisconsin, a manager of a 250 cowherd uses a computer to record the milk production of each cow twice daily. It compares results with previous ones to determine cows who yields are dropping. The computer is also used in the preparation of reproduction records. It lists the number of days since cows calved, the number of days since cows were bred and the pregnancy status of each cow. Thus, it can list the cows expected to be in heat, distinguish dry cows and predict calving dates.

In Indiana, a consultant uses a computer in a mobile van to design balanced and rationed feeding schedules for different herds of dairymen in the area. The computer calculates forage/concentrate ratios, fibre level in rations as well as daily vitamin and mineral dosage. By estimating the cost of feed required to produce unit quantity of milk the computer can help the dairymen to calculate their profits. The computer rations also enable the cows to produce longer, (5 lactation periods instead of 2.7) and to give more milk of better quality.[5]

10. Computers in prediction of outbreak of pests in agriculture (United States). Researchers at Michigan State University have used microcomputers to predict the outbreak of pests in an apple orchard scab. The computer was 100 per cent accurate and by using the predictions, fungicides were applied at the appropriate time, thus maximising the effectiveness of the fungicides and eliminating additional sprayings.[6]

11. Computer networks (United States and Canada). There are computer networks

that microcomputers can link up with by modem. These networks give information on weather conditions and forecasts, commodity prices and current market prices for livestock.[7]

B. Other microelectronics/electronics applications

12. "Microelectronic abacus" (China). It is reported that in March 1979, the Chinese Abacus Association produced a new instrument called "microelectronic abacus". An electronic calculator is quicker than an abacus for multiplication and division; but an abacus is faster for addition and subtraction. The strong points of both have therefore been incorporated into the new device which "consists of an integrated micro-circuit in the upper part with an abacus below. Either part can be used independently. This combination has dramatically increased the efficiency of this ancient calculating tool."[8] The electronic abacus is being mass-produced in Beijing and Hangzhou.

13. Microelectronics and rural telecommunications (Guyana). In Guyana, a programme is being developed to apply microelectronics for the improvement of rural telecommunications systems, in particular, to improve the efficiency of equipment.

14. Microelectronics applications in irrigation systems (Thailand). Thailand is at present considering the introduction of commercial application of advanced modular technology for low-cost field-level irrigation system to its Northeast region. The conventional grade-level irrigation systems are difficult to instal because of slightly rolling terrain. When field-level distribution canals must be elevated by a metre or so, a considerable area of land is lost to cultivation because

of the field requirements. In order to overcome this problem engineers at the Mekong Commission surveyed a variety of prefabricated modular channel technologies, and identified one which has potential for relatively small-scale local production and low installed cost, while greatly reducing the land area diverted from agricultural use.[9]

15. Rural electronic telephone exchanges (India). The Indian Telephone Industry has stepped up the production of small-scale rural electronic telephone exchanges as a result of the successful performance of the first-batch production. It is reported that about 100 ten-line telephone batches are already in operation in rural areas in Kerala, Maharashtra, Rajasthan and Uttar Pradesh. Two hundred additional exchanges are expected to be operational soon.[10]

16. Use of electronics in traditional medicine (China). The *acupoint* pressing method is used to diagnose diseases in China. A recent development has been the replacement of the fingers by an electronic device used for pressing at the *acupoints.* With the device, time is saved in diagnosis especially in disease surveys. In Machen District in Hubei Province general surveys of carcinoma and esophagus have been carried out. In the traditional finger-method of diagnosis two surveys involving 8,600 and 4,500 people required 15 and eight medical workers respectively, and a period of one year to complete. A similar survey in which the electronic device was used covered 16,536 people and only four medical workers over a period of less than a year.[11]

II. Robotics and Numerically Controlled Machines

17. Food robots (Japan). Robots are being used in small Japanese restaurants. Some examples are: an egg-breaker, a sushi-squeezer, a gyoza-packer, a Yakitori-piercer, warped food-maker, and egg-frier, etc. They are known to perform as well as professional cooks, at a speed nearly 10 times that of a human cook.[12] A small Tokyo company (Suzumo Machinery Works) holds the patents on sushi robot. It has sold 1,500 units in Japan and 30 in the United States. In 1982, Suzumo began selling a robot that, with a robotic arm and claws, makes rice patties. It is reported that "quality is excellent and the speed is impressive, 1,200 an hour, or three times faster than an experienced sushi chef."[13] The fish however still must be sliced by hand and stacked on the rice patty. Here then is an appropiate example of combining the new technology with labour-intensive operations rather than replacing the latter altogether.

18. Industrial robots (Japan). Shima Seiki Company employing 310 workers has an "army of mechatronics" which produces three times the output with the same number of employees. Its product is a knitting machine, of many varieties. With the introduction of the NC machine tools, the company can adjust and adapt to the changing requirements of customers.[14]

19. Automation of traditional wood products industry (Japan). Manufacture of Japanese wooden products is concentrated mainly in small firms, which are rapidly introducing NC-machine tools and robots in order to be able to withstand competition from other firms. For example, Hikari Furniture Co. introduced ten NC-machine tools in 1981, and subsequently installed painting robots and transfer robots; Furuyama Sangyo bought an NC-machine tool the cost of which was shared with the machine-tool maker and the NC-maker.[15]

20. Automation in sheep shearing (Australia). The cost of shearing sheep by hand is becoming prohibitive in Australia. Therefore, the Australian Wool Corporation has sponsored a research project to develop a fully automatic and numerically-controlled mechanism for sheep-shearing. Future research will concentrate on producing a "robot" shearer which would be owned by contractors and leased to farmers for short periods.[16]

III. Optoelectronics

A. Laser techniques

21. Use of laser for irradiation of silkworms (China). In the Anhui province of China, laser has been introduced by the Institute of Biology of the Chinese Academy of Sciences to irradiate silkworms. The new breeds are of higher quality: they also economise feed. The cocoon shell increases by 1.58 per cent, increasing the output value per sheet of silkworm egg paper by 3.5 per cent while the output value of mulberry leaves goes up by 13.16 per cent and the length of natural silk increases by 150 metres.[17]

22. Laser processing machines (Japan). The major advantages of laser processing machines are: (i) they can operate with high precision; and (ii) each machine can perform several tasks such as cutting, welding, drilling and heat treatment through adjustment of the duration of laser application. In addition they do not require a high level of skill to operate and they are economical.

In Japan laser applications include the laser-light scalpel used in medicine and laser machines used in industry for cutting, welding, drilling and measuring. A

Japanese Government subsidised project undertaken by the Electro Technical Laboratory in Tsulcuba Science City aims at developing laser machines of up to 20 kW output.[18]

23. Use of optical fibres in telecommunications (France). The French Post Telephone Telegraph (PTT) has launched a large programme for utilising fibre optics for all medium and long haul transmission links. To date optical fibres have been used to link post offices in Paris. A 100 km transmission link with repeaters every 20-30 km is planned between LeMans and La Fleche and Anger in the west of France. The TAT 8 transatlantic cable is to be inaugurated in 1988. Optical fibre transmissions have several advantages over conventional copper cables. Their technical advantages include low signal attenuation, total immunity to electromagnetic and radiofrequency interference and unwanted tampering with or tapping of transmitted information, very high band width for simultaneous transmission of speech data, text, still and moving pictures, compactness, ease of installation and maintenance, safety of use (no risk of sparking, electrocution or overheating) and high speed of data transmission. Economically, they have been shown to be cheaper for links of above 200 mg and prices are expected to drop rapidly in the future.

24. Optical fibres in telecommunications (United States). Washington and New York are now connected by optical glass fibres. The lasers that transmit the signals flash at 90 million times a second. At that rate the whole contents of the *Encyclopaedia Britannica* can be transmitted over a single pair of fibres in one minute.[19]

25. Fibre optic systems (Japan). Over 400 optical fibre systems were installed in Japan between 1978 and 1980. In 1982, the major users included the iron and steel industry, the automobile industry and in monitoring railroad and highway traffic.

In the Fukuyama iron and steel works, fibre-optic transmission is required for in-house data transmission. This has eliminated interference from power cables supplying power to the plant. By 1981, the fibre optic transmission system had a cable length of 16 kilometres.[20]

26. Photovoltaic power supply in Hammam Biadha Sud (Tunisia). In February 1983 National Aeronautics and Space Administration (NASA) Lewis Research Centre installed four stand-alone photovoltaic systems in Tunisia. One such system was at a village (Hammam Biadha Sud) 150 km from Tunis.

In this village a central photovoltaic power system provides power to three sectors (domestic, commercial and public) of the village.

In the commercial sector two stores and a mill, a hairdresser, a coffee shop require up to 5 kWh of electricity per day. The domestic sector consists of 22 homes provided with 37 kWh daily to power refrigerators, lights and television sets. In the public sector 20 kWh is used daily to supply a clinic, a mosque, a cultural centre, a school and street lights. The array sub-system also consists of storage batteries and an inverter for d.c./a.c. conversion. With an inverter efficiency of 80 per cent, 119 kWh of electricity is produced per day in July and 65 kWh per day in December.

The second system is a farmhouse system serving the need of a residence remote to Hammam Biadha. The large three-family dwelling has a demand of 1.5 kWh. This system consists of a solar array, a conditioning and control sub-system, a battery sub-system and a 120 DC/230 V AC, 50 HZ inverter. Daily load is 6 kWh in July and 3 kWh in December (again assuming 80 per cent inverter efficiency).

The third and fourth photovoltaic systems in Hammam Biadha supplies pumps of two drip irrigation systems. One feeds water to a one hectare greenhouse where vegetables are grown while the other irrigates a one-hectare fruit orchard. Each system requires up to 750 cubic metres of water a day.[21]

27. Las Barrancas solar village (Mexico). This project is a part of the bigger project entitled "Sonntlan" which is one of the several projects developed by the Government of Mexico and the Federal Republic of Germany. It consists in an integrated use of solar energy for providing desalinated water, electricity, ice and cold space to the Pacific community of fishermen of Los Barrancas village in the Northwest of Mexico. The objectives of the project are: (a) to demonstrate the benefits from the use of solar energy; (b) to evaluate the performance and reliablility of the installed equipment in real working conditions; (c) to analyse the technical, social and economic feasibility of the solar system for replication in other parts of Mexico, and (d) to improve the living standards of the rural inhabitants.

The integral solar system installed in the village consists of a "service area in which solar and wind energy are transformed into useable forms..." The radiant solar energy is transformed into thermal energy by means of flat-plate collectors and photovoltaic cells. The flat-plate collectors heat water which is used to

produce ice which is then used to preserve sea products during transport. Hot water is also used for heating brine in a multi-stage flash seawater desalination plant and in a fish-processing plant. The electric energy generated by the photovoltaic cells is normally used for driving motors in the absorption type refrigeration unit. A photovoltaic generator also provides energy for a radiotelephone system which links the village with the national telephone network.[22]

28. Photovoltaic power supply to Schuchuli village (United States). A 3.5 kWp, 120 voH photovoltaic array was installed in a Papago Indian reservation in southern Arizona. The 100 inhabitants are provided with electric power for water pumping, lighting, refrigeration, services and village housekeeping. Direct current (DC) systems are used to reduce losses, costs and the additional complexities of DC/AC converters. A battery of 2,380 amp-hr capacity is incorporated to provide power at night. The control system includes automatic switches to disconnect part of the solar array to prevent overcharging of the batteries and automatic load shedding to prevent excessive discharging of the batteries.[23]

29. Solar-power TV sets (Niger). In 1968, an experimental solar panel was installed near Niamey to power the education TX sets at a nearby school. It is reported that by 1973, about 800 students in 22 classes were receiving instructions through solar-powered television sets. It is forecast that by 1985, over 80 per cent of the population would be covered by solar-powered educational programmes.

30. Photovoltaic cells (Colombia). In Colombia, the use of solar cells for power

generation was first considered in 1978 when TELECOM, the National Telecommunications Company, with the technical assistance of the Solar Energy Group of the National University, started a programme to provide 5,000 villages with radiotelephones. The system consists of solar cells panels, a battery, a control unit, and a power conditioner. TELECOM has bought 2,950 systems for a total of 114 kW peak. It is considered to be one of the largest programmes in the world which uses solar generators for rural telecommunications.[24]

31. Photovoltaic power supply to mosques (Egypt). In an agreement with the German Federal Ministry for Research and Technology, the Egyptian Electricity Authority has embarked on the installation of photovoltaic systems. The first such system provides power to operate the public address system in the Mit Abu El-Koum village mosque. The total power supplied is 368 W and the unit is equipped with a 48 volt storage battery. The other photovoltaic units are to be used for: water pumping and storage, water desalination, water purification, irrigation, a spray plant, a sea bury, hazard beacon, colour television, food cooling and storage and water electrolysis. The total installed power will be approximately 11 kW.[25]

32. Reverse osmosis water desalination plant (Mexico). Solar Reverse Osmosis (SORO) is an experimental project undertaken by the Federal Republic of Germany and the Government of Mexico. The project comprises design, construction and testing of a photovoltaic-powered brackish water desalination unit which was installed in 1980. The objectives of the project are:

- to evaluate the transformation of solar energy into electricity which is capable of making a reverse osmosis desalination unit work continuously

during the daytime;

- to evaluate the ability of these combined systems to provide potable water on the basis of an independent source of energy. Evaluation of the project will concentrate on the plant performance, number and causes of failures, equipment lifetime, water quality and economic feasibility.[26]

33. Photovoltaic-powered irrigation (United States). In Mead, Nebraska an irrigation system operated by photovoltaic array was set up in a project sponsored by the Department of Energy. For its first two years of operation failure rate of the system was two per cent and important statistical information on such aspects as sorting and cleaning have been obtained.[27]

34. Photovoltaic systems (Mali). At least five photovoltaic systems have been installed in Mali with French assistance. These are used primarily for pumping water to rural areas. A 16 kWp system installed in a hospital provides power for water pumping, refrigeration of pharmaceuticals, lighting and cooling of operating rooms.

IV. Satellite Technology

A. Remote sensing applications

35. Application of remote-sensing technology (China). In agriculture, LANDSAT MSS images have been utilised in agriculture to compile geological maps, and to investigate changes in the acreage of the Yellow River Delta, and migration of river channels, etc.

36. Use of remote-sensing technology in forestry (Thailand). The Royal Forest Department of Thailand has utilised LANDSAT imagery for surveying existing forest land for the whole country, surveying and assessing areas of shifting cultivation in Northern Thailand and for conducting a change detection study of forest conversion in the seven eastern provinces of the country. Other studies done by means of remote-sensing techniques in Thailand include the measurement of rubber plantations in the eastern and southern parts of the country.

The use of remote sensing techniques reduced the time and personnel required for forest surveys and made it possible to draw up policies and plans for forest conservation and protection.

In the future, remote sensing would be used to monitor the country's forest resources on a routine basis, in view of the government policy to maintain 50 per cent of the country under forests.[28]

37. Crop inventory applications of remote sensing (Bangladesh). In Bangladesh remote-sensing techniques were used to measure the extent of winter rice in some regions. When the results of remote sensing were compared with field estimates a high correlation was found to exist.[29]

38. Soilmapping by remote sensing (Egypt). Remote sensing techniques were used for mapping soils of an area over 100,000 square kilometres in El Shazly in Egypt. The maps obtained were at a scale of 1:500,000 and analysis differentiated arable from non-arable land. The soils were classified further into seven grades. This basic soil classification enables priority areas for agricultural development to be

identified.[30]

39. Detection of areas of copper deposits (Pakistan). A rock classification map, derived from LANDSAT images over Pakistan, has been used to predict copper deposits in the country. Of the 19 sites chosen from the map, five were found to have evidence of surface mineralization indicating the possibility of an enriched copper zone below the surface.[31]

40. Identification of salt-affected soils (India). A study in India has succeeded in delineating salt-affected soils around the Ganges Plain area. Salt-affected soils were easily detected in the MSS bands four and five. This information is important in an attempt to reclaim soils for agriculture in areas where population pressures make this necessary.[32]

41. IDRC remote sensing project (Sudan, Bolivia, Bangladesh, Mali and United Republic of Tanzania).[33] In the Sudan project, personnel was trained, a remote-sensing unit was set up and thematic maps of the surface water hydrology, soils and erosion, vegetation and soil use in parts of the Kordofan and White Nile provinces were obtained.

In Bolivia, a series of thematic maps on geology, soils and soil use was produced. This was compiled in the form of an atlas entitled "Area Desaguadero Procesamiento Digital de Datos Multispectrales". In addition a training programme on remote-sensing techniques was undertaken.

The Bangladesh project also had a training component and involved production of

thematic maps by computers. Coloured LANDSAT images were analysed to produce hydrological maps of the hydrology of the Ganges Basin.

In Mali, a large number of maps on geology, hydrography, soil use, forest cover and agricultural potential in the south western part of the country were produced.

The main purpose of the project in Tanzania was to assess the natural resources in the Rukwa region. Maps outlining the biophysical zones of the Sumbawanga and Mpanda districts, and the agricultural potential of the entire region (for crops such as rice, corn, tobacco and cotton) were produced. Details on the geology, accessibility and irrigation possibilities were also obtained.

B. Satellite broadcasting

42. The bare-foot microchip (Ecuador). In Ecuador, rural radio service broadcasts advertisements on the prevention of goitre, with satellite technology. The result, after a period of one year, is an increase in the proportion of households using iodised salt from 5 per cent to 98 per cent.

V. New materials

A. Ceramics and amorphous silicon

43. Microwave drying of ceramics (China). Ceramics production is a traditional industry in China. Products from the conventional methods of drying (hot-air drying) are susceptible to deformation and cracking. Microwave drying, which has been recently employed, ensures uniform drying resulting in a higher quality ceramic product.[34]

44. Amorphous silicon in solar cells manufacture (Japan). Amorphous silicon is superior to single-crystal silicon in physical, chemical, mechanical, electrical, magnetic and optical properties. Cells made of single-crystal silicon cost US$ 4,000 to 5,000 per kW of output while those from amorphous silicon are one hundredth or less of the above cost. Developments in amorphous silicon production are thus the key to cost reduction in photovoltaic power conversion.

In Japan, several companies now manufacture watches, radios and calculators which utilise amorphous silicon solar cells. Conversion efficiency as high as 6.9 per cent has been achieved.[35]

B. Fibre reinforced composites

45. Fibre reinforced cement roof sheets (Zimbabwe). In Zimbabwe a production unit for the production of sisal-reinforced concrete roof sheets was set up. Chopped sisal is added to a 3.2 ratio of cement and sand at 1.25 per cent of the total weight.

The production unit which is set up at the Seke International Red Cross Camp is supplied with chop fibres by women. With one moulding table, 24 sheet moulds and four curing racks, production by four men is estimated at ten sheets per day.

The sisal-cement roofing sheets are marketed at 60 per cent of the price of asbestos roof sheets. The sale price per 2 metre sheet is 2.5 Zimbabwean dollars[36] of which 45 per cent represents the cost of raw materials and 55 per cent a return for labour, capital outlay and profit. Costs could be lowered in the rural areas where sand and sisal can be obtained at less expense.

The total cost of the project was 371.81 Zimbabwean dollars. Technical assistance was obtained from the United Kingdom Intermediate Technology Building Materials Workshop.

The sisal-reinforced concrete sheets have been widely used in the area and their demand considerably exceeds supply.[37]

VI. Biotechnology

46. *Production of Malaria vaccine (Australia and Papua New Guinea). The

Institute of Medical Research in Melbourne in conjunction with the Papua New Guinea Institute of Medical Research has utilised the recombinant DNA technique to produce a vaccine against malaria.

The new technique involves the production of protein antigens which have been tested against blood sera of people in malaria-prone areas of Papua New Guinea. Extensive testing is to be carried out by the World Health Organisation.[38]

47. *Cloning of tea (Malawi). The Tea Research Foundation of Malawi is undertaking research with a view to raise the yields of small tea holders and thereby raise rural living standards. In a major innovation the Foundation has developed clones and methods of propagating their high quality including characteristics such as pest resistance which would be particularly important to small farmers. UNFSSTD is supporting the Foundation with a research grant for this endeavour.

48. *Nitrogen fixation on rice paddy soils (International Rice Testing and Improvement Programme). The above UNDP-financed programme aims to assist paddy rice growers to reduce their dependence on artificial nitrogen fertilisers which have become too expensive for poor farmers in developing countries. The role of microorganisms in fixing nitrogen as part of the process of natural plant nutrition has been studied.[39]

49. *Production of ethanol from cellulosic material (Philippines). The

Philippine Government requested UNIDO to assist in a project intended to investigate the potential of ethanol production from cellulosic materials. This project consists of three stages:

(i) a technical and economic study of the feasibility of ethanol production from cellulosic materials on a commercial scale and the establishment of a pilot plant;

(ii) preparation of detailed designs for the pilot plant; and

(iii) construction of the pilot plant.

The techno-economic study has been completed. The potential feedstocks studied were bagasse, rice hull, coconut husks, bananas, wood wastes from logging operations and forest industries and wood from fast-growing tree plantations.

Hydrolysis tests have been performed and it is proposed that a pilot plant be set up to process these materials. The preliminary design on the pilot plant provides for versatility to serve important research and development needs.

Besides the basic enzymatic cellulose to ethanol production it can be used to investigate acid hydrolysis, animal feed production tests, research for production of other enzymes (e.g., amylolytic enzymes for hydrolysis of starch) and hydrolysis and fermentation equipment. The total cost of the pilot plant is estimated at US$ 2.1 million. This includes training costs of four to six persons for six to twelve months abroad.[40]

50. *Ethanol from molasses (Brazil). An ethanol plant at Sao Luis distillery has been started in Brazil in collaboration with Alfa-Laval of Sweden. Ethanol is produced from a feedstock of molasses and cane juice syrup.

51. *Rum waste for fuel (Canada). A distillery in Nova Scotia (Canada) has tested a system producing methane from waste mollasses from rum production. It is expected to turn a 27 million litre disposal problem into an energy resource.

52. *Banana ethanol (Jamaica). A contract has been awarded to D. G. Malcolm and Associates, (a Company based in Saskatoon) to investigate the prospect of ethanol production from agricultural by-products, e.g. banana, citrus fruit and coffee pulp, in Jamaica where at present 20 to 40 per cent of the banana crop is rejected because the fruit is marked, undersize or otherwise unsuitable for export.

VII. Miscellaneous

A. Irradiation techniques

53. Use of irradiation in wine-making industries (China). The Fifth Radio Factory of Qiqihae in North East China has produced a wine aging system utilising ultrashort,

ultrasonic and ultraviolet rays. Treatment of wine by these rays for 8 to 12 minutes gives an aging effect equivalent to six months storage and improves the wine quality. The Luzhou Brewery in Sichuan Province produces a popular product "Luzhou Dawue" liqueur which is treated with X-rays in doses of between 80,000 and 120,000 roentgens.[41]

54. *Heat/irradiation technique for inactivating virus in meat products (Uruguay). Scientists at the Meat Institute of the Faculty of Veterinary Sciences have developed methods to eliminate foot and mouth disease from meat and meat products without alteration of the quality. Traditionally a long holding time was required to achieve the acidity required to destroy the virus. This new method involves a balanced combination of heat, heat/irradiation and heat/cold dehydration techniques. Since foot and mouth disease is the main obstacle to expanding exports of meat from Uruguay, it is expected that this breakthrough would be of great economic benefit. The project is being undertaken by the government of Uruguay with the assistance of the UNFSSTD.

B. New chemical processes

55. New pyrolysis techniques for fuel production (Ghana, Indonesia, Papua New Guinea). New pyrolysis techniques using incineration processes have been developed by the Georgia Institute of Technology of the United States. In these processes, biomass residues are convertible into more environmentally acceptable fuels. Biofuels in three forms are produced: char (fuel value 28-31.5 kJ kg^{-1}), oil (fuel value 21-23 kJ kg^{-1}) and gas (fuel value 5.6-7.5 MJ/m^{-3}). Control can be incorporated to vary the relative yields of these products.

In collaboration with the Ghanaian Building and Road Research Institute in Ghana, an experimental plant has been set up in Kumasi. In Ghana, pyrolitic converters are constructed with local materials. One unit can process six dry tons of sawdust a day and four other units can process 1.5 tons daily. Similar units using rice husks, wood and other wastes have been constructed in Indonesia and Papua New Guinea.[42]

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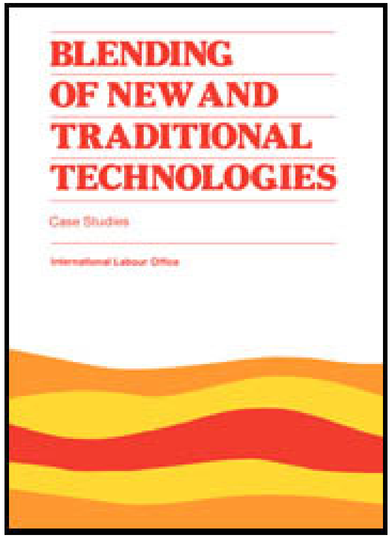

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